FOOTWEAR INDUCED CHANGES OF REARFOOT MOVEMENT AND ENERGY CONSUMPTION IN DISTANCE RUNNING

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Background

Oxygen consumption is decisive for distance running performance

Main approach: Cardiovascular training

→ Training methods!

However, mechanical alterations may provide a basis for further increases: BW, technique, footwear
Background

- No gain by using an ‘energy return’ shoe
  (Mercer et al 2003)
- 1.1% decrease in VO$_2$ consumption
  (Morgan et al 1996)
- Oxygen consumption can be varied by 1 - 2%
  (Frederick 1984)

Background

Comparison of VO$_2$ and EMG changes by elastic versus viscous midsole:
- VO$_2$ and EMG not systematically changed
- Individual response partly explained by EMG
  (Nigg et al 2003)
- Significant differences between most and least comfortable shoe
  (Nigg 2001)
Purpose
Relate effects of medial and lateral heel inserts on rearfoot motion, VO$_2$ consumption, muscle activation and comfort during treadmill running.

Hypotheses
Individual responses
VO$_2$ changes relate to changes of neuromuscular effort
VO$_2$ changes relate to perceived comfort

Methods
Participants
9 recreational runners
age = 23 - 40 yrs
BW = 70.6 ± 7.1 kg
height = 1.74 ± 0.07 m

Regular training ≥25 km/wk

No injuries >3 yrs, 'neutral' feet
Methods

Electromyography
Bipolar surface EMG (biovision) from 8 muscles; left thigh & leg
VM, VL, BF, TA, PE, GM, GL, SO

Kinematics
Customised rearfoot goniometer
Sagittal plane video (Basler, 101 Hz)

Tibial accelerometer & synch unit (biovision)
→ Recorded onto datalogger (compaq)

Methods

Oxygen Consumption ($\text{VO}_2$)

$\text{MOXUS VO}_2$ analyser system; expiratory volumes of $\text{CO}_2$ and $\text{O}_2$ (15 s intervals)

Protocol
Preparation
Familiarisation (Quinton treadmill)
Run at ~80% of 5k time
For 3 x 16 min with 6 – 8 min breaks
Assessment/Analysis

- EMG: rectified, integrated over stride cycle → 'neuromuscular effort'
  (Moritani et al. 1993)
- Maximum eversion from barefoot reference
- Stride frequency, knee and ankle kinematics
- VO₂ (average: 10th & 11th minute)
- VAS (0–10) of perceived exertion and comfort
- Heart rate
Results
No alterations in knee or talocrural joint kinematics

Minimum Rearfoot Angle

Results
• $\text{Vo}_2$: no order effects
  → subjects were running at steady state

Oxygen Consumption
Results

160 - 105 - 149 mVs \rightarrow 3 - 1 - 2 ; 8 muscles

- Rearfoot motion was systematically altered
- Magnitude of changes was overall 'smaller' than the intervention
- Oxygen consumption varied significantly: medial shoe demonstrating highest values
- Integrated EMG corresponds to VO$_2$
- At best, a trend for perceived comfort relating to energy expenditure was observed
Discussion

Explanation?
• Preferred movement path!

• Muscle forces needed to maintain joint congruence
• Soft tissue vibrations?
• Implications for fatigue → injury
Conclusion

Footwear induced alterations of rearfoot movement affect muscle activity and total energy consumption

A certain amount of physiological pronation is necessary

Musculoskeletal system may attempt to maintain joint congruence by muscle forces

Need to identify factors determining the ‘preferred movement path’ of individuals

Thank you!